NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

May 5, 2020

Flight Data Recorder

Specialist's Factual Report
By Kyle Garner

1. EVENT SUMMARY.

Location:	Chicago, IL
Date:	November 11, 2019
Aircraft:	Embraer ERJ-145 LR
Registration:	N619AE
Operator:	Envoy Air
NTSB Number:	DCA20LA013

On November 11, 2019, about 0742 central standard time (CST), Envoy Air flight 4125, an Embraer ERJ-145 LR, registration N619AE, experienced a right main landing gear collapse during landing on runway 10L at O'Hare International Airport (KORD), Chicago, Illinois. There was blowing snow at the time of the event. There were no injuries to the 41 passengers and crew onboard, however, the airplane was substantially damaged. The flight was operating under the provisions of 14 *Code of Federal Regulations (CFR)* Part 121 as a regularly scheduled passenger flight from Piedmont Triad International Airport (KGSO), Greensboro, North Carolina to KORD.

2. FLIGHT DATA RECORDER GROUP

A flight data recorder (FDR) group was not convened.

3. FDR Carriage Requirements

The event aircraft, N619AE, was manufactured in 1998 and was operating such that it was required to be equipped with an FDR that recorded, at a minimum, 34 parameters, as cited in Title 14 CFR Part 121.344(d).

4. DETAILS OF FDR INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following FDR:

Recorder Manufacturer/Model:	**Honeywell 980-4700 SSFDR**
Recorder Serial Number:	**SSFDR-09483**

4.1. Honeywell 980-4700 SSFDR Description

The Honeywell solid state flight data recorder (SSFDR) records airplane flight information in a digital format using solid-state flash memory as the recording medium. The SSFDR can receive data in the ARINC 573/717/747 configurations and can record a minimum of 25 hours of flight data. It is configured to record 128 12-bit words of digital information every second. Each grouping of 128 words (each second) is called a subframe. Each subframe has a unique 12-bit synchronization (sync) word identifying it as subframe 1, 2, 3, or 4. The sync word is the first word in each subframe. The

data stream is "in sync" when successive sync words appear at proper 128-word intervals. Each data parameter (for example, altitude, heading, and airspeed) has a specifically assigned word number within the subframe. The SSFDR is designed to meet the crash-survivability requirements of TSO-C124.

4.1.1. Recorder Condition

The recorder was in good condition and the data were extracted normally from the recorder.

4.1.2. Recording Description

The FDR recording contained approximately 54 hours of data. Timing of the FDR data is measured in subframe reference number (SRN), where each SRN equals one elapsed second. The event flight was the last flight of the recording and its duration was approximately two hours and fifteen minutes. The parameters evaluated for the purpose of this report appeared to be in accordance with federal FDR carriage requirements.

4.1.3. Engineering Units Conversions

The engineering units conversions used for the data contained in this report are based on documentation from the aircraft manufacturer. Where applicable, the conversions have been changed to ensure that the parameters conform to the NTSB's standard sign convention that climbing right turns are positive (CRT=+).[1]

Table A-1 lists the FDR parameters verified and provided in this report. Additionally, Table A-2 describes the unit and discrete abbreviations used in this report.

4.1.4. Pressure Altitude

This FDR records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (inHg). The pressure altitude information presented in the FDR plots and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

4.2. Time Correlation

Correlation of the FDR data from SRN to the event local time, CST, was established by using the recorded Time GMT[2] hours, Time GMT Minutes, and Time GMT Seconds and then applying an additional -6 hours offset to change GMT to CST.

Accordingly, the time offset for the event flight data from SRN to local CST is the following:

CST = SRN + 5784.

Therefore, for the rest of this report, all times are referenced as CST, not SRN.

[1] CRT=+ means that for any parameter recorded that indicates a climb or a right turn, the sign for that value is positive. Also, for any parameter recorded that indicates an action or deflection, if it induces a climb or right turn, the value is positive. Examples: Right Roll = +, Pitch Up = +, Elevator Trailing Edge Up = +, Right Rudder = +.

[2] GMT is Greenwich Mean Time which is also known as Coordinated Universal Time (UTC).

4.3. FDR Plots and Corresponding Tabular Data

Figures 1 to 4 contain FDR data recorded during the November 11, 2019 event. All the parameters listed in Table A-1 are either plotted or provided in tabular data in Attachment 1 to this report.

These plots are configured such that right turns are indicated by the trace moving toward the bottom of the page, left turns towards the top of the page, and nose up attitudes towards the top of the page.

Figure 1 is a plot of basic parameters for the entire event flight from KGSO to KORD, from 05:20:00 to 07:42:40. Figure 2, 3, and 4 are plots of basic, flight control, and autoflight parameters for the last 90 seconds of the event flight, respectively.

In Figure 1 the data begins at 05:20:00 when the aircraft was on the ground at KGSO. At 05:26:18, the gear weight-on-wheels (WOW) indication switched from ground to air, indicating the aircraft had departed KGSO. The aircraft climbed normally to a cruising altitude of 36,000 feet. At approximately 06:11:00, the aircraft began a descent to KORD. At 07:12:00, the aircraft was configured for an approach to runway 10L at KORD. Approximately three minutes later, at 07:15:43, engine 1 and 2 N1 increased rapidly from 40% to 85% and the aircraft began to climb, indicative of a go-around. The lowest recorded radio altitude during this approach was 96 feet above ground level (AGL). The aircraft then climbed to an altitude of approximately 4,750 feet and made another approach to runway 10L.

In Figure 2, the data begins at 07:41:10 when the aircraft is on its second final approach to runway 10L at KORD. At the beginning of the plot the data show the radio altitude was 518 feet AGL, the autopilot was engaged, and the indicated airspeed was approximately 146 knots. The first gear WOW indication was 47 seconds later, at 07:41:57. Three seconds after the aircraft touched down the inboard and outboard wheel brake pressure began to increase. Five seconds after touchdown, at 07:42:02, all four thrust reverser halves indicated deployed. The ground speed was 127 knots. At 07:42:15, with thrust reversers still deployed, inboard wheel brake pressure at approximately 340 psi, and outboard wheel brake pressure at 90 psi, the aircraft began to turn to the left. As the aircraft slowed to 39 knots, the thrust reversers indicated stowed at 07:42:23. As the reversers stowed, inboard and outboard wheel brake pressure increased, and the aircraft continued to turn to the left. Two seconds later, at 07:42:29, a spike in vertical acceleration of 1.64 g and lateral acceleration of -0.85 g was recorded. Two seconds later, at 07;42:41 the gear WOW indication switched from ground to air. Ground speed was 12 knots. The plot ends at 07:42:40 after the ground speed indicated zero and the aircraft was at rest.

Figure 3 begins at 07:41:10 and shows 90 seconds of flight control parameters during the second final approach to runway 10L at KORD. The data show that upon the gear WOW indication switching from air to ground, at 07:41:57, all four spoiler panels commanded open. Left and right inboard spoiler panels stowed at 07:42:23. Left and right outboard spoiler panels then stowed four seconds later, at 07:42:27. Furthermore, between 07:42:27 and 07:42:30 right roll increased from approximately 2.5 deg right to 12 deg right, likely due to the aircraft departing the paved surface and the right wing impacting the ground. This plot also shows control column, control wheel, and rudder pedal inputs. Resultant rudder and aileron surface positions are also shown.

There was a one second offset between the left and right control column position datapoints. Per the FDR manufacturer, the offset it due to the combined latency of the internal circuit delays of the data acquisition unit (DAU) and the delay time of the external RS-422 inter-DAU bus. The manufacturer noted that there was no requirement to synchronize the two inputs. The data are shown in Figure 3 and the tabular data uncorrected.

Figure 4 begins at 07:41:10 and shows 90 seconds of autoflight parameters during the second final approach to runway 10L at KORD. At the beginning of the plot the data show that at approximately 518 feet AGL the autopilot was engaged, the vertical flight director mode was configured to capture the glideslope, and the lateral flight director mode was configured to maintain the localizer. At 07:41:30, the autopilot was disengaged, however, vertical and lateral guidance remained on the flight director until touchdown. A master warning indication was recorded at 07:42:30, 32 seconds after touchdown. One second later, at 07:42:31, gear WOW switched from ground to air. One second later, a master caution indication was also recorded. The plot ends at 07:42:40 after the aircraft had come to a rest.

The corresponding tabular data used to create figures 1 to 4, including Time GMT Hours, Time GMT Minutes, Time GMT Seconds and autopilot modes are provided in compressed electronic comma separated value (*.csv) format as Attachment 1 to this report.

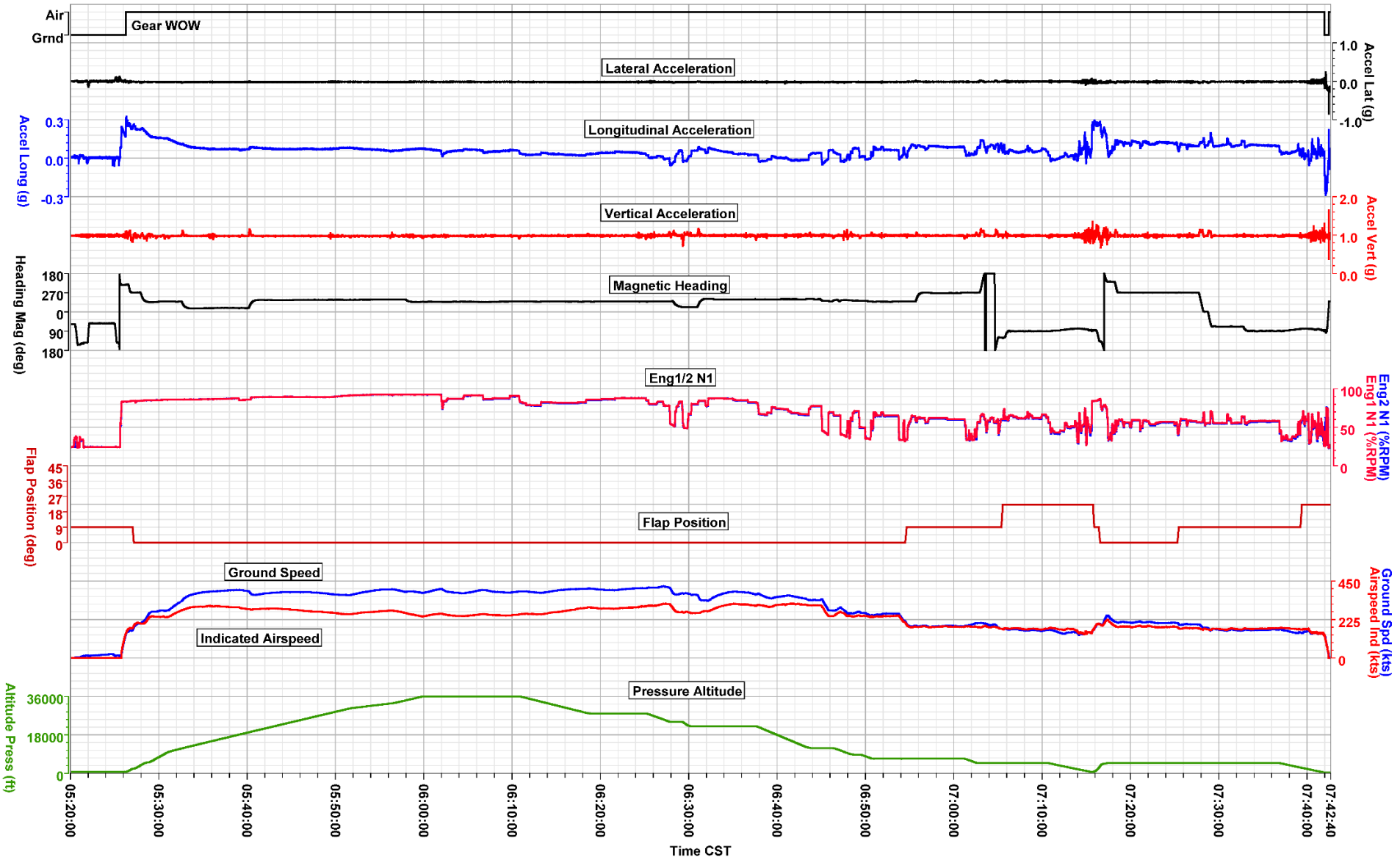

Figure 1. Plot of Basic Parameters for Full Event Flight

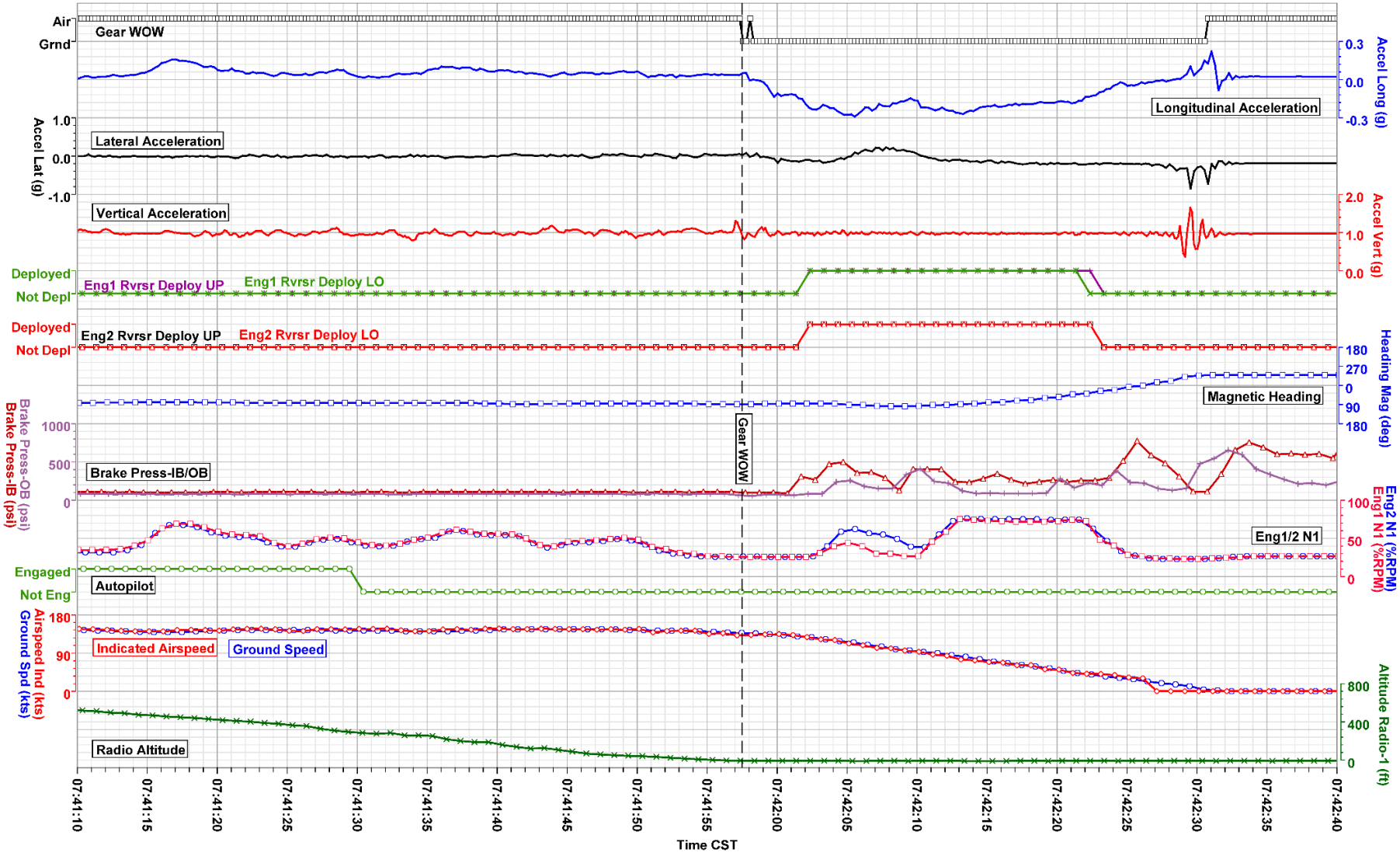

Figure 2. Plot of Basic Parameters for 90 Seconds of Event Flight

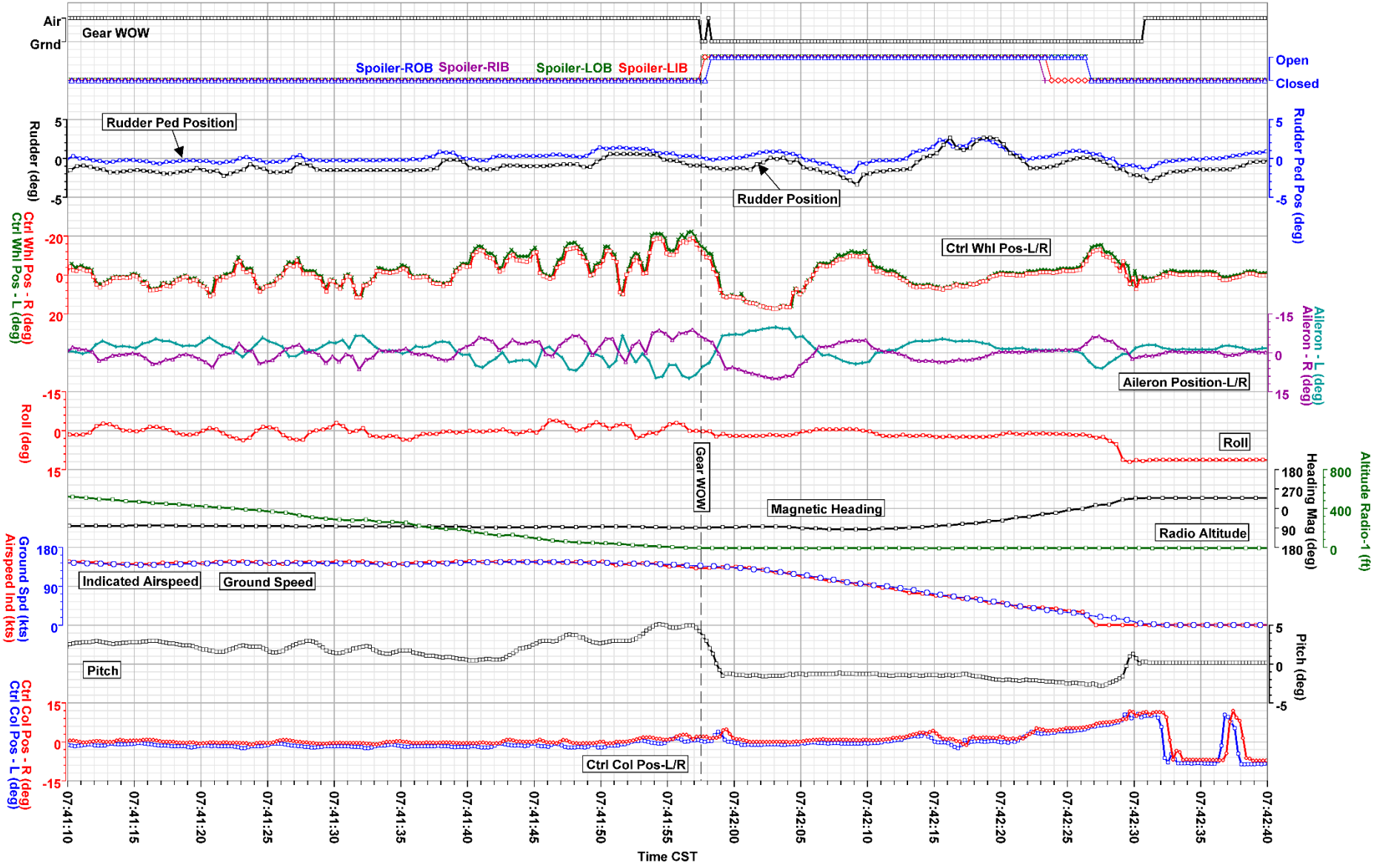

Figure 3. Plot of Flight Control Parameters for 90 Seconds of Event Flight

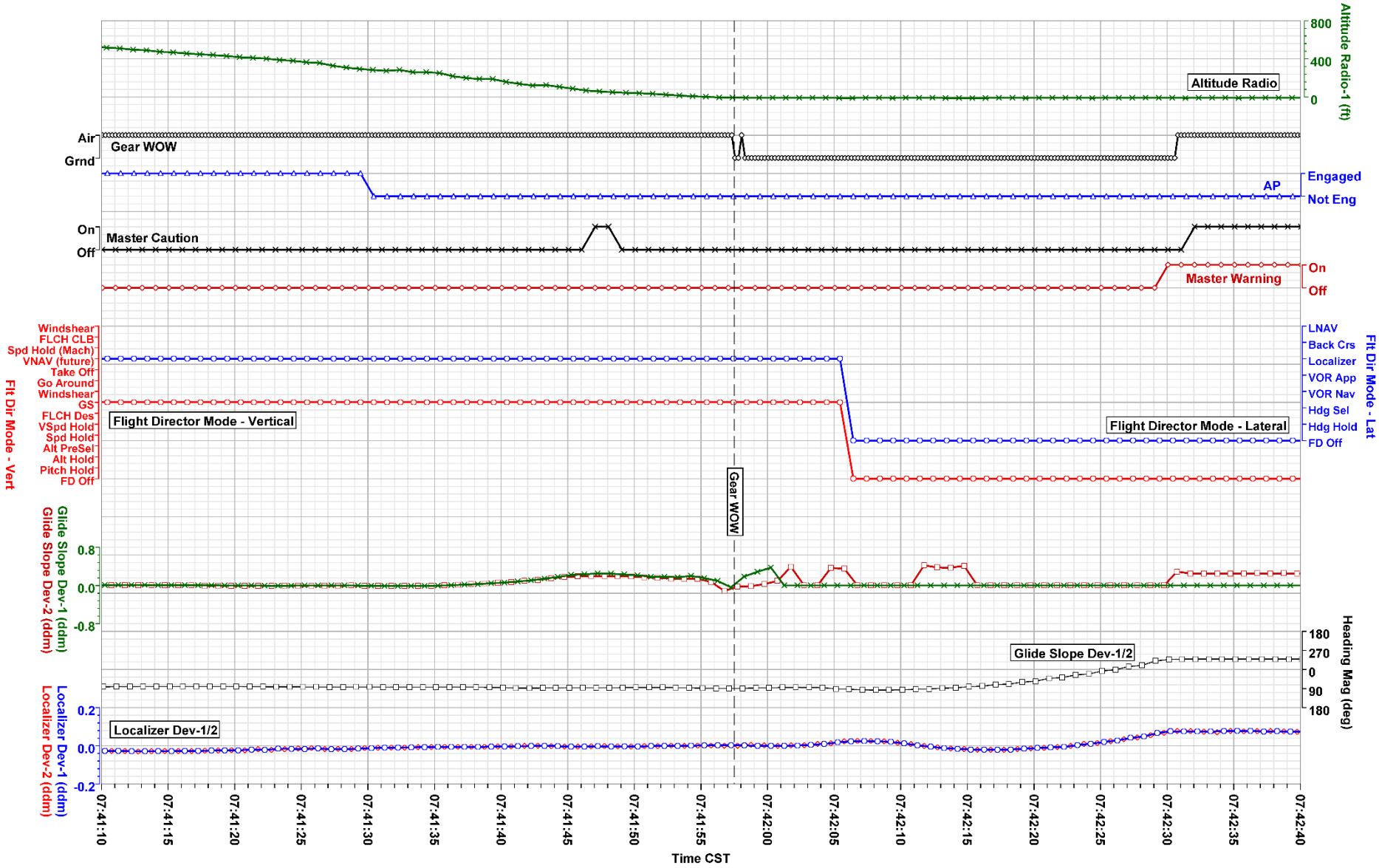

Figure 4. Plot of Autoflight Parameters for Last 90 Seconds of Event Flight

APPENDIX A

This appendix describes the parameters provided and verified in this report. Table A-1 lists the parameter names, plot/table labels, and units. Additionally, Table A-2 describes the unit and discrete abbreviations used in this report.

Table A-1. Verified and provided FDR parameters.

Plot/Table Labels	Parameter Names	Units
Accel Lat	Lateral Acceleration	g
Accel Long	Longitudinal Acceleration	g
Accel Vert	Vertical Acceleration	g
Aileron - L	Aileron Position – Left	deg
Aileron - R	Aileron Position – Right	deg
Airspeed Ind	Indicated Airspeed	kts
Altitude Press	Pressure Altitude	ft
Altitude Radio-1	Radio Altitude	ft
AP	Autopilot Engaged	-
Brake Press-IB	Brake Pressure Inboard Wheels	psi
Brake Press-OB	Brake Pressure Outboard Wheels	psi
Ctrl Col Pos - L	Control Column Position – Left	deg
Ctrl Col Pos - R	Control Column Position – Right	deg
Ctrl Whl Pos - L	Control Wheel Position – Left	deg
Ctrl Whl Pos - R	Control Wheel Position – Right	deg
Eng1 N1	Engine 1 N1	rpm
Eng1 Rvrsr Deploy LO	Engine 1 Thrust Reverser Deployed – Lower	-
Eng1 Rvrsr Deploy UP	Engine 1 Thrust Reverser Deployed – Upper	-
Eng2 N1	Engine 2 N1	rpm
Eng2 Rvrsr Deploy LO	Engine 2 Thrust Reverser Deployed – Lower	-
Eng2 Rvrsr Deploy UP	Engine 2 Thrust Reverser Deployed – Upper	-
Flap Position	Flap Position	deg
Flt Dir Mode - Lat	Flight Director Mode – Lateral	-
Flt Dir Mode - Vert	Flight Director Mode – Vertical	-
Gear WOW	Gear Weight-on-Wheels	-
Glide Slope Dev-1	Glide Slope Deviation – Left Computer	ddm
Glide Slope Dev-2	Glide Slope Deviation – Right Computer	ddm
Ground Spd	Ground Speed	kts
Heading Mag	Magnetic Heading	deg
Localizer Dev-1	Localizer Deviation – Left Computer	ddm
Localizer Dev-2	Localizer Deviation – Right Computer	ddm
Master Caution	Master Caution	-
Master Warning	Master Warning	-
Pitch	Pitch Angle	deg
Roll	Roll Angle	deg
Rudder	Rudder Position	deg
Rudder Ped Pos	Rudder Pedal Position	deg
Spoiler-LIB	Spoiler Status – Left Inboard	-
Spoiler-LOB	Spoiler Status – Left Outboard	-
Spoiler-RIB	Spoiler Status – Right Inboard	-
Spoiler-ROB	Spoiler Status – Right Outboard	-
Time GMT Hrs	Time GMT Hours	hrs
Time GMT Min	Time GMT Minutes	min
Time GMT Sec	Time GMT Seconds	sec

NOTE: This FDR records pressure altitude, which is based on a standard altimeter setting of 29.92 inches of mercury (in Hg). The pressure altitude information presented in the FDR plots and in the electronic data has not been corrected for the local altimeter setting at the time of the event.

NOTE: Parameters with a blank unit description in table A-1 are discretes. A discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.

Table A-2. Unit and discrete abbreviations.

Unit and discrete abbreviations	Descriptions
AGL	above ground level
deg	degrees
ddm	difference in depth of modulation
kts	knots
g	g
in	inches
ft	feet
hrs	hours
min	minutes
psi	pounds per square inch
sec	seconds
rpm	revolutions per minute
WOW	weight-on-wheels

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.